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STUDENT REPORT

VANDENBERG LAUNCH AND LANDING SITE:
POST-CHALLENGER...IS THE DREAM ALIVE?

MAJOR JAY J. ALONIS 88-0093

"insights into tomorrow"

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This paper provides insight into the potential reactivation of the Vandenberg Shuttle site as a National Space Transportation System launch complex. It examines: a) major unresolved facility problems and the extent of system deactivation, b) Vandenberg (post-Challenger) launch requirements and payload-to-orbit launch vehicle performance; c) the effect of a replacement Orbiter on the Space Transportation System launch rate, and d) Vandenberg Shuttle reactivation/Shuttle-C developmental costs.

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PREFACE

On 28 January 1986 the Space Shuttle Challenger exploded leaving the United States space program in shambles. The Challenger accident resulted in an unresolved dilemma (caretaker status) for Vandenberg as a Shuttle launch complex. With less reliance on the Space Shuttle and increased emphasis on expendable launch vehicles for routine space launches, the need for a west coast Shuttle complex is uncertain.

The purpose of this paper is to provide program managers insight into the possible reactivation of the Vandenberg Launch and Landing Site as a Space Shuttle complex. The paper analyzes two major phases of Vandenberg's Shuttle evolution: the major facility/system developmental problems experienced during activation and the effects of Minimum Facility Caretaker Status upon potential reactivation. Additionally, the paper explores the future need for a west coast Shuttle facility. The material used in developing this paper is current as of October 1987.

The author extends a special thanks to his wife for her patience during the development and typing of this paper.

ABOUT THE AUTHOR

The author has a diversified background involving Strategic Air Command (SAC) missile operations/maintenance and the Air Force Operational Test and Evaluation Center (AFOTEC) Space Shuttle Evaluation Program. His experience as a SAC missile officer included duties as a Minuteman II ICBM missile combat crew commander, chief of a site maintenance branch, chief of an electro-mechanical branch, Chief of Wing Scheduling, Chief of Job Control, and chief of a facility maintenance branch. He has two and one half years of Space Shuttle test and evaluation experience. At the Vandenberg Launch and Landing Site (VLS) he served in the following positions: Ground Support System Evaluator, Chief of Ground Support System Operations, and Chief of VLS Program Integration. He has written extensively on the VLS Shuttle program and is a published author. His credits include the AFOTEC Flight Verification Vehicle report, the VLS Deactivation report, and an extensive contribution to the Air Force Operational Assessment of the Space Transportation System Final Report. Additionally, he helped develop the AFOTEC Space Transportation System Launch Rate Capability Model.

His military awards include the Meritorious Service Medal and the Air Force Commendation Medal (one Oak Leaf Cluster).

The author has a Bachelor of Arts in Geography from Louisiana Tech University. He earned his Master of Science in Business Administration Safety Management from Central Missouri State University. He is married and has two children.

TABLE OF CONTENTS

LIST OF ILLUSTRATIONS

FIGURES

TABLES

EXECUTIVE SUMMARY

REPORT NUMBER 88-0095

AUTHOR(S) MAJOR JAY J. ALONIS, USAF

TITLE VANDENBERG LAUNCH AND LANDING SITE: POST-CHALLENGER...IS THE DREAM ALIVE?

I. Purpose: To provide insight into the potential reactivation of the Vandenberg Shuttle site as a Space Transportation System (STS) launch complex.

II. Problem: Predict the Vandenberg Shuttle site potential for reactivation by examining major unresolved facility problems and the extent of system deactivation, post-Challenger Vandenberg launch requirements and payload-to-orbit launch vehicle performance, the effect of a replacement Orbiter on the STS launch rate, and Vandenberg Shuttle reactivation/Shuttle-C developmental costs.

III. Data: The Challenger accident forced DOD to review its immediate need for Vandenberg's Shuttle complex. As a result of this review, the west coast Shuttle complex was placed into Minimum Facility Caretaker Status. The 2 October 1986 deactivation decision virtually terminated all facility/system construction, testing, and support. Program cancellation left critical questions unanswered involving flight hardware and

CONTINUED

ground support system interfaces. Additionally, problems with exhaust duct hydrogen entrapment, Launch Mount holddown post stress, Launch Control Center air filtration, and valve reliability pose as expensive obstacles to reactivation.

Vandenberg's future as a Shuttle launch site will likely be decided during the next four years. The decision will be based upon military requirements, payload delivery capability, Orbiter/Expendable Launch Vehicle (ELV) availability, reactivation costs, and political considerations. Nine of Vandenberg's 10 originally planned STS launches have been remanifested to ELV missions. As a result of post-Challenger Shuttle modifications and mission constraints, a revised Vandenberg Shuttle payload-to-orbit capability of 11,700 pounds has placed the Shuttle in direct competition with less expensive expendable launch vehicles. Although a replacement Orbiter is currently under construction, its contribution to the STS launch rate is minimal. The Air Force Operational Test and Evaluation Center STS Launch Rate Model indicates that a four Orbiter fleet would provide a net increase of one to two launches per year over a three Orbiter fleet. Construction of a replacement Orbiter does not appear to be cost effective in lieu of the marginal impact on the launch rate. Despite AFOTEC's calculation of a 12 mission per year maximum STS launch rate (based on four Orbiters), the Shuttle provides a unique capability of performing two-way crew transportation, manned on-orbit tasking, Strategic Defense Initiative experimentation, spacecraft servicing, and the ability to return cargo from space. Based upon these capabilities, Vandenberg has a remote chance for STS reactivation.

Vandenberg's future as a Shuttle site may hinge on reactivation costs. A conservative extrapolated reactivation cost of $500-$600 million dollars is foreseen. This estimate, however, does not include post-Challenger modifications or the hydrogen entrapment fix. It appears Vandenberg's destiny is evolving around a new heavy-lift launch vehicle. On 4 February 1987 HQ USAF directed AFSC (with NASA participation) to develop a heavy-lift launch vehicle (75,000 to 150,000 pound payload-to-orbit capability). NASA favors a derivative of the Shuttle (without the Orbiter) while the Air Force favors a new system. The Air Force goal is to reduce the current $3000 per pound cost of a Titan launch. The prohibitive expense of acquisition may force NASA and the Air Force into a joint venture. If the NASA heavy-lift design (Shuttle-C) is accepted, then the potential for reactivating the Vandenberg Shuttle site as a heavy-lift launch complex significantly improves.

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IV. Conclusions: The reactivation of Vandenberg's Shuttle launch complex is contingent upon a need for a west coast Shuttle facility and a strong commitment by the military to manned polar spaceflight. These don't exist, nor are they likely to in the near future. Vandenberg's future is polarizing around expendable, heavy-lift vehicles, not the Shuttle.

Chapter One

INTRODUCTION

This paper is intended to provide insight into the potential reactivation of the Vandenberg Shuttle site as a National Space Transportation System launch complex. It examines major unresolved facility problems and the extent of system deactivation, Vandenberg (post-Challenger) launch requirements and payload-to-orbit launch vehicle performance, the effect of a replacement Orbiter on the Space Transportation System launch rate, and VLS reactivation/Shuttle-C developmental costs.

> The Air Force was very enthusiastic about the Shuttle from the beginning. Since the 1950s, the military had toyed with the concept of an airplane-like vehicle which could operate both in the atmosphere and outer space. The Air Force recognized that a shuttle-craft, which took men into orbit, could also deploy satellites, rendezvous with satellites presently in space, and do on-orbit maintenance or retrieval as well (3:6).
>
> On 10 June 1969, the DOD was forced to terminate its Manned Orbiting Laboratory (MOL) program. The basic problem was that the MOL had the misfortune of reaching a peak financial need. . . when the war in Vietnam was draining off all available assets. The program was behind schedule, had already reached its projected budget ceiling of $1.5 billion, and was expected to exceed $3 billion by 1974 (3:6).
>
> In one fell swoop, all military manned spaceflight came to an abrupt end. With the MOL cancellation, the Administration was in effect stating that the time had come to limit the financial outlays in space exploration. Of all the alternatives the Shuttle Test Group was considering, only one offered the possibility of reducing the cost of doing business in space - the Shuttle (3:7).

The 28 January 1986 Space Shuttle Challenger accident again altered the course of military manned spaceflight, taking it back 17 years to the MOL program cancellation. The deactivation of Vandenberg's Space Transportation System (STS) complex to Minimum Facility Caretaker Status has significantly reduced the Department of Defense (DOD) flexibility and capability for polar orbital space operations. The 2 October 1986 deactivation decision virtually terminated all facility construction and care,

critical system development and check-out, operations and maintenance, logistical support, system inspection, and safety programs. Vandenberg's future as a Shuttle launch site will be decided during the next four years. This decision will be based upon the strength of national resolve for manned space flight, military requirements, STS payload delivery capability, Expendable Launch Vehicle (ELV) performance, replacement Orbiter availability, and facility reactivation operating costs.

Prior to the deactivation decision, Vandenberg's evolution as a Shuttle launch complex had experienced considerable technical delays and program setbacks. STS construction began in January 1979, using existing Manned Orbiting Laboratory facilities as a cost-saving initiative (13:1). The Initial Operational Capability (IOC) was originally scheduled for December 1982. But Orbiter delivery problems, thrust augmentation deficiencies, unexpected areas of cost growth, and unplanned launch pad modifications (7:28) delayed IOC until a baseline capability was declared in October 1985. Vandenberg's first Shuttle launch was scheduled for 15 July 1986. The Challenger accident and subsequent grounding of the STS fleet, however, canceled all Vandenberg near-term Shuttle launch requirements. Despite Challenger's loss, incomplete ground system testing and a hydrogen entrapment problem within the Space Shuttle Main Engine exhaust duct would likely have delayed Vandenberg's first scheduled Shuttle launch date. Vandenberg launch facilities and systems continued developmental testing and modification until program cancellation was announced in October 1986.

From Shuttle developmental preparations to its present Minimum Facility Caretaker Status, the Vandenberg STS program has traveled nearly full circle since its inception. As with many research and development projects, Vandenberg experienced developmental problems. These problems included, but were not limited to, hardware failures, uncontrolled schedule slips, lack of operational discipline, faulty configuration management, inadequate supply support, and limited manpower/training experience levels (25:2-10).

Program cancellation left critical questions unanswered involving flight hardware and ground system interfaces. The deactivation decision occurred just as Vandenberg was undergoing its most important system validation (Flow A). Additionally, modifications in progress or planned were terminated. The facilities and systems have been placed into a long-term preservation mode.

Vandenberg's reactivation is contingent upon a need for a west coast Shuttle facility and a strong commitment by the military to manned polar spaceflight. Neither presently exist, nor are they likely to occur in the near future. Vandenberg's future as a launch site is polarizing around expendable, heavy-lift vehicles, not the Shuttle.

Chapter Two

VANDENBERG SHUTTLE SITE ACTIVATION

Vandenberg Launch and Landing Site (VLS) activation was an enormously complex task in terms of its physical layout, organizational relationships, and personnel requirements. Despite extraordinary efforts by the Air Force, the National Aeronautics and Space Administration (NASA), and contractor personnel, developmental problems proved particularly troublesome. Consequently, the program ultimately got no closer than five months to a launch capable configuration (7:28). This chapter addresses several key hardware and facility technical problems which directly impacted Vandenberg's activation efforts and pose significant reactivation issues. They include the Launch Mount hydrogen entrapment problem, holddown post stresses, Launch Control Center environmental integrity, and ground support system valve reliability. Commentary on these subjects is intended to provide a perspective on potential obstacles to VLS reactivation (i.e., magnitude of effort and cost/time of modification).

VANDENBERG SHUTTLE FACILITIES/SYSTEMS

The Facility Verification Vehicle (FVV) tests and Flow A were specifically designed to identify deficiencies so that timely corrective action could be taken to ease the quantity and severity of impacts on the first operational mission. FVV was predominately a form and fit check-out of mechanical systems. The scope of FVV was limited in that not all systems were ready for operational testing nor was the Orbiter Enterprise capable of interfacing with those systems which were operational. Flow A, a more operationally-oriented effort, was intended to duplicate many of FVV's limited mechanical checks with greater fidelity while validating VLS facility, flight hardware, and ground support system interfaces. These interfaces included electrical connections, gas and liquid commodities flow, and two-way Mission Control Center data communication.

As a cost-saving initiative, the Air Force terminated Flow A shortly after the Solid Rocket Booster stacking operations at Space Launch Complex-6 were complete. Cancellation of this activity creates significant long-term program ramifications for reactivation. Although all known technical issues involving operational readiness were previously addressed (16:7), incomplete compliance verification on critical systems establishes the potential for unanticipated reactivation

problems. To the extent that system testing identifies problems, it is imperative that the solutions be fully developed and ready to implement. If left unresolved, the Vandenberg Launch and Landing Site will face an open, undefined development effort which could jeopardize the launch schedule and program budget. Primary hardware concerns identified as significant are summarized in the following categories:

a. Hydrogen Entrapment. Hydrogen entrapment within the VLS Launch Mount main engine exhaust duct (during Space Shuttle Main Engine (SSME) shutdown) is a significant concern (21:34). Should the entrapped hydrogen detonate, the enclosed duct could reflect the blast effect upward toward the Shuttle, thereby causing extensive damage or vehicle loss. This condition must be resolved prior to a Flight Readiness Firing or first launch. Currently, a steam inerting system has been selected to alleviate the problem (20:--). This solution involves injecting super-heated steam into the launch duct during SSME ignition. Although design engineering has been authorized, actual implementation has been deferred until reactivation. The proposed fix will cost an estimated $36 million dollars and require approximately two years of construction, modification, and testing (22:--).

b. Launch Mount Holddown Posts. The VLS Launch Mount must be configured to prevent potential Space Shuttle Vehicle (SSV) damage from launch generated stresses. NASA computer simulations indicate Vandenberg SSV lift-off stresses may exceed vehicle design (12:1-3). Although the holddown posts have been modified to alleviate this problem, special testing designed to validate computer predictions proved inconclusive (27:1). After several years of extensive Launch Mount modifications and integrated test operations, sufficient information is not available to establish the level of confidence needed to assure a safe launch from Vandenberg (12:3).

c. Launch Control Center (LCC). The close proximity of the launch pad and the LCC (approximately 1,200 feet) has caused concern about LCC bioenvironmental integrity during launch and post-launch periods (14:1). Possible LCC contamination from launch by-products (hydrogen chloride (HCl)) and marine elements is a serious problem. The presence of HCl in the LCC represents a potential human health hazard and will act as a corrosive catalyst on computer circuits.

Battelle, Hewlett Packard, and Aerospace Corporation studies estimate that significant HCl concentrations will spread over the launch site, with the heaviest fallout occurring within a 1,500 to 2,500-foot radius of the Launch Mount. The LCC breathing air is drawn from ventilating shafts located approximately 1,400 feet from the Launch Mount.

The tests indicate that the following time-dependent outside HCl concentrations will cause HCl concentrations within the LCC to exceed acceptable levels. Indoor HCl

levels will exceed [both] the 5 parts per million (ppm) health criteria and the 3.95 parts per billion equipment damage criteria when the [launch complex] outside HCl concentration/time figure exceeds 222.8 ppm/per minute and 1.76 ppm/per minute respectively (14:1).

Measures to protect LCC personnel from HCl and other contaminates have received considerable attention over the past four years, resulting in the approval of an activated carbon air filtering system for the LCC. This system, although not purchased, must be installed prior to launch. The filter will protect LCC personnel, but it does not satisfy environmental standards recommended for LCC electronics (34:2). The ingestion of HCl and marine chlorides into the LCC through the air intakes must be solved before the LCC can be declared a safe environment for operators and sensitive electronic systems (19:--).

d. Valves. *Primary* valves used in the critical STS cryogenic and hypergolic propulsion ground support systems were original MOL program hardware and had to be extensively modified to work. Many of the valves are old (Anderson-Greenwood valves are 25 years old) (18:5), spare parts difficult to obtain (spare valves found in a Jackass Flats, Nevada, junkyard), and repairs often had to be worked on an individual basis (18:--). Furthermore, despite Aerospace Corporation objections, VACCO valves/regulators were selected as a cost-savings measure. On the Thor program, these valves/regulators suffered from a terrible performance record which resulted in the blackballing of VACCO products (28:41). Numerous internal failures have caused their performance to be unreliable (17:--). In the hydrazine system, eleven failures were attributed to VACCO products in one year (28:41). Although most valve problems were solved, long-term maintainability and reliability is questionable.

Chapter Three

VANDENBERG SHUTTLE SITE DEACTIVATION

On 2 October 1986, The Secretary of the Air Force announced VLS would be placed in Operational Caretaker Status. This action (revised to Minimum Facility Caretaker Status on 20 February 1987) essentially signaled Vandenberg's near-term demise as an operational west coast Shuttle facility. The decision was based on several primary reasons: (1) suspension of Shuttle flights and a projected VLS budgetary shortfall throughout fiscal years 1987 to 1991, (2) post-Challenger accident modifications and flight constraints reduced VLS Shuttle payload-to-orbit insertion capability to that of expendable launch vehicles, and (3) a Vandenberg dedicated or loaned Orbiter would reduce the NASA Kennedy Space Center launch rate (30:--). This chapter traces two phases of the deactivation effort, from the initial decision through the October 1987 completion. The first, or concept phase, briefly reviews Air Force deactivation options and associated operating costs. Additionally, it illustrates the extent of VLS facility and system deactivation. Finally, the preparation phase examines the deactivation timetable and associated planning.

CONCEPT PHASE

The Air Force contemplated three Vandenberg operating levels following the suspension of Shuttle launches: Operational Caretaker, Facility Caretaker, and Mothball.

Operational Caretaker (estimated cost - $200 million dollars/year), would retain a critical core of approximately 1200 personnel, allow VLS to remain compatible with the Kennedy Space Center launch facility, and permit launch within 18 months of a reactivation decision (16:Appendix I). Facility Caretaker (estimated cost - $150.1 million dollars/year), would maintain approximately 750 people, perform only essential maintenance on basic facilities, and require 36 months for reactivation (16:Appendix I). Mothballing (estimated cost - $25.9 million dollars/year), would reduce personnel strength to 150, place facilities and equipment in long-term preservation, and increase the lead time needed for launch to at least 48 months (16:Appendix I).

Deactivation to Operational Caretaker Status appeared to be the best possible decision. The Facility Caretaker and Mothball options were perceived as unacceptable because critical personnel

would have been lost and VLS facilities would not have been kept current (16:5). Additionally, the Mothball option would not have allowed a 1992 launch (16:Appendix I). Four months later, as the DOD space "picture" cleared, the Air Force re-evaluated Vandenberg's role and on 20 February 1987 announced a transition to Minimum Facility Caretaker Status (MFCS). MFCS is a level of deactivation between Facility Caretaker and Mothball configurations (although more closely aligned to Mothball). Deactivation to MFCS was completed in October 1987. Minimum Facility Caretaker Status (estimated cost - $50 million dollars/year) is intended to ensure the ability to reactivate Vandenberg when launch requirements dictate (16:Appendix I). Reactivation to a launch capable condition will require a minimum four-year lead time with high management/technical risk. MFCS consists of the following assumptions, conditions, and activities (15:--; 23:--):

a. Facilities and equipment will be preserved with intent to reactivate for Space Shuttle launches.

b. All Vandenberg Shuttle facilities, launch support systems, structures, and equipment will be placed in a long-term preservation mode.

c. All equipment will be drained, purged, sealed, protected, and placed into long-term storage.

d. An accurate system configuration baseline will be established and maintained.

e. The overall Shuttle Processing Contractor (SPC) work force will be reduced to approximately 275-325 people. This will be accomplished by eliminating all launch team personnel and flight hardware technicians, and significantly reducing engineering, logistics, and support activities. Facility preservation technicians will constitute the work force majority.

f. VLS Air Force Program Office manning will drop from 265 to approximately 49 people.

g. Alternate uses for VLS facilities and equipment will be explored.

Figure 1 illustrates the VLS SPC manpower reduction throughout program deactivation (23:--). The chart shows that contractor employment peaked at 3400 people in FY 1985. Upon completion of Flow A Solid Rocket Booster destacking operations, 2100 people remained. Within weeks of the October 1986 deactivation decision, manpower was reduced to approximately 1200 personnel. By January 1987 the strength dwindled to 850. Final Minimum Facility Caretaker manning leveled at approximately 300 personnel in December 1987.

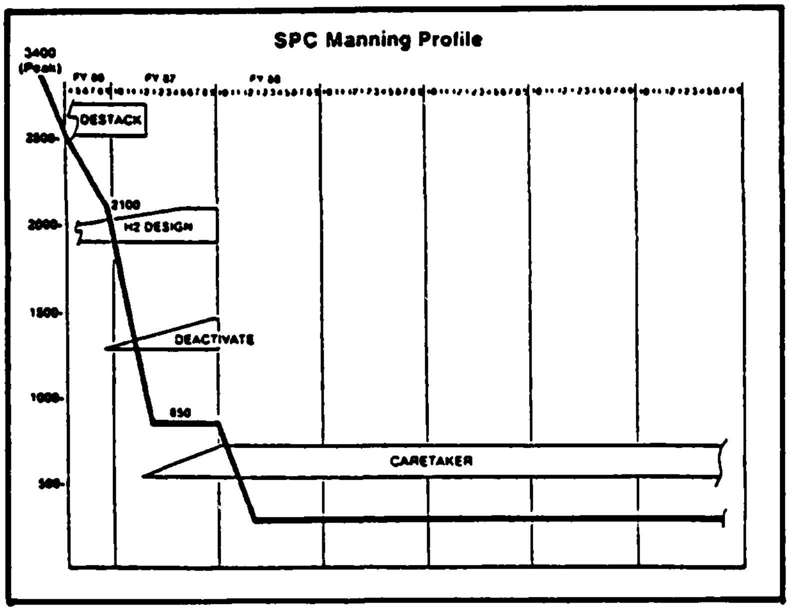

Figure 1. VLS Deactivation Manning

For VLS reactivation Figure 2 projects a manpower increase to 500 people at launch-minus-four-years (23:--). During the next four years, personnel strength will continue to increase. Manpower would ultimately ramp up to 2100 people for system status reviews, the exhaust duct hydrogen fix, system reactivation, and the start of ground system testing. Launch operations are expected to require a Shared Processing Team (SPT) of 2500 people (2100 Vandenberg personnel/400 Kennedy personnel).

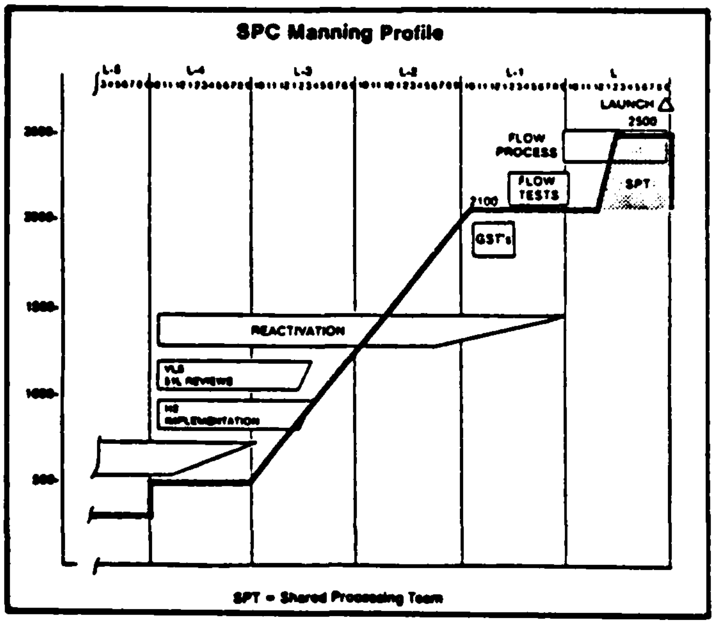

Figure 2. VLS Reactivation Manning

PREPARATION PHASE

High quality, comprehensive planning documents (short/long-term) are key to a successful deactivation program and critical for any subsequent reactivation. Developing integration plans and establishing realistic program timetables are foremost among near-term deactivation priorities (15:2).

Air Force and contractor planners have assessed the status of the Vandenberg complex, defining requirements, and developing a practical concept of deactivation. Realizing the scope and magnitude of such an effort, a Master Integrated Deactivation Plan was developed. The master plan is divided into three sub-plans, each addressing a separate stage of the Minimum Facility Caretaker period: deactivation, caretaker, and reactivation (15:2).

The Deactivation Plan is a comprehensive document containing the philosophy, concept, procedures, and timetable for placing VLS systems and facilities in a deactivation mode. The planned deactivation completion date was achieved in October 1987.

The Caretaker Plan provides the guidance and procedures to maintain VLS facilities and systems in a deactivated state pending a reactivation decision. The plan is logical and complete. If followed, it should establish a well-defined and maintained "baseline" for system reactivation.

The Reactivation Plan is intended to return Vandenberg from a deactivated state to an operational and launch capable configuration. The plan was scheduled to be released during March 1987; however, given the perceived uncertainty of VLS shuttle requirements, reactivation has not received serious consideration (32:--). VLS philosophy regarding reactivation planning was a "plan to write a plan" (32:--). A clearly defined reactivation plan is needed to avoid costly reactivation delays while working with limited people and resources.

Chapter Four

VANDENBERG SHUTTLE SITE FUTURE

Vandenberg's future as a Shuttle launch site is currently open to speculation, but will likely be decided during the next four years. The decision will be based upon operational requirements, payload delivery capability, Orbiter/ELV availability, and reactivation/operating costs. Negative results in any category could delay reactivation and trigger an indefinite standdown of the Vandenberg Shuttle program. This chapter examines each of these topics and provides commentary on the future of Vandenberg. The assessment is based upon discussions, management briefings, and interviews with Air Force, NASA, the Aerospace Corporation, and other Shuttle contractor personnel.

OPERATIONAL REQUIREMENTS

There are no officially sanctioned DOD or NASA requirements addressing a need for VLS reactivation through 1994 (26:--). Air Force access-to-space priorities have shifted away from the Space Shuttle as the sole launching platform, thus diminishing Vandenberg's STS role. The new philosophy calls for a diversified launch program based on the use of expendable launch vehicles complemented by a series of Kennedy Space Center STS launches.

An audit of Vandenberg's ten originally planned Shuttle payloads (thru 1994) reveals all but one payload (STA-10 (Space Station crew manning)) are being remanifested to expendable launch vehicles or Kennedy Space Center Shuttle missions (26:--). These payloads are not deemed sufficiently important to require Vandenberg STS reactivation. Table 1 correlates Vandenberg DOD and NASA launch requirements to potential future launch vehicles and locations (26:--).

PAYLOAD	LAUNCH ALTERNATIVES	
	VEHICLE	SITE
DOD		
2 DOD	STS or Titan IV	KSC or WTR*
P-675	STS	KSC
P-888	STS	KSC
SPAS	STS	KSC
NASA		
POLAR	STS or DELTA	KSC or WTR
SRL-2	STS	KSC
NOAA-K	Titan II	WTR
LANDSAT-6	Titan II	WTR
SPACE STATION		
SPACE STA-5	Titan IV	WTR
SPACE STA-10	STS	WTR

* WTR - Western Test Range (Vandenberg AFB, CA)

NOTES: (1) The DOD and NASA payloads have firm launch requirements regardless of VLS status.

(2) Polar space stations platforms would require STS VLS capability.

Table 1. Vandenberg Shuttle Launch Requirements

The Challenger accident (51-L) has prompted the Air Force to analyze its space policy/doctrine and begin establishing realistic long-term priorities. Senior Air Force leaders are increasingly reluctant to rely solely on the Space Shuttle for DOD missions. They have essentially abandoned the Shuttle program while focusing their attention on developing expendable launch vehicles as the primary access to space. This lack-of-faith in the STS program has hampered Systems Command's ability to provide clear long-term guidance regarding VLS reactivation. Any attempt to address future Vandenberg Shuttle requirements, establish inter- or intra-command points of contact, working groups, or steering committees will be ineffective without definitive guidance.

Guidance must begin with a revision of our Military Space Doctrine, AFM 1-6. Our current doctrine is eight years old and reflects broad, nebulous concepts regarding military man in space. The only reference to manned spaceflight states "Manned and unmanned space systems provide flexibility in meeting requirements on a timely, accurate, and reliable basis" (8:5). This lack of vision and long-term thinking has resulted in a $5 billion dollar military manned space expenditure ($1.5 billion

for the MOL program (3:7)/$3.5 billion for the STS program (16:16)) at Space Launch Complex-6, with no return on the investment.

PAYLOAD DELIVERY CAPABILITY

The Shuttle's polar payload delivery capability will be a significant factor in determining Vandenberg's reactivation. Post-Challenger accident modifications, flight constraints, and operating limitations have reduced the Vandenberg Shuttle payload delivery to that of existing expendable launch vehicles. Table 2 depicts this revised Shuttle capability in the context of weight-to-orbit capability of current and future launch vehicles (29:1).

PAYLOAD-TO-ORBIT LIFT CAPABILITIES
(Payload Approximations for Vandenberg Launches to High Inclination/Low Earth Orbits)

VEHICLE	PAYLOAD WEIGHT (lbs)
Scout	400
Delta I	5,500
Delta II	6,800
Atlas E (SGS-2)	5,800
Atlas H	5,500
MX (Space Launch Vehicle)	5,200
Titan II	4,000
Titan IIIB	6,000
Titan 34D	27,400
Titan IV	30,300 *
Shuttle (pre 51-L)	26,900 * (109% power/FWC SRBs)
Shuttle (post 51-L)	11,700 ** (104% power/Steel SRBs)
Heavy-Lift Launch Vehicle	75,000-150,000 *

* Projected capability
** Projected capability includes a 3,500 lb management reserve penalty for unforeseen problems

Note: East coast equatorial launches have a payload-to-orbit weight advantage of 2:1 over west coast polar launches. Unlike equatorial launches, polar launches cannot use the earth's rotation as an advantage in achieving orbit.

Table 2. Vandenberg Polar Lift Capability

Original requirements called for a minimum VLS payload lift capability of 32,000 lbs into a polar orbit and an associated payload landing weight goal of 22,500 lbs (7:5). Performance data from actual Space Shuttle flights reveal a substantially reduced VLS capability of 15,200 lbs for pre-Challenger missions

(using 104% SSME power/Steel Case SRBs) and a 12,100 lbs limit for post-Challenger missions (7:5-7).*** Despite proposed thrust augmentation enhancements, using 109% SSME power (100-104% now used), lightweight/high performance External Tanks, and filament wound case (FWC) Solid Rocket Boosters (SRB,) the Shuttle is not expected to achieve its original 32,000 pound payload lift capability (7:5-7). This factor alone places the Shuttle in direct competition with less expensive, expendable launch vehicles. Reactivation based solely upon payload-to-orbit capability is not foreseen.

*** In a 12 March 1987 NASA briefing before the United States Senate (Subcommittee on Science, Technology and Space Committee on Commerce, Science and Transportation) the NASA Deputy Administrator cited a post-Challenger 21,200 pound payload capability for VLS. The 21,200 pound capability, however, was calculated using 109% main engine thrust and filament wound Solid Rocket Boosters (24:2), neither of which are flight certified.

REPLACEMENT ORBITER

DOD, NASA, and National Security Council officials have stated that to forego building a replacement Orbiter would weaken Vandenberg's case for reactivation (16:13). Although the decision to build a replacement Orbiter has been made, efforts to reduce the national debt, a tight DOD budget, and competing national programs may hamper this effort.

Since a replacement Orbiter is perceived as vital to Vandenberg's future as a Shuttle launch facility, the following replacement issues are significant concerns: (1) Would a replacement Orbiter provide an effective means of increasing the launch rate? (2) What is the long-term need for the Shuttle's unique capabilities?

The NASA Advisory Council Task Force recommended that KSC base its STS manifest planning on a 12-mission-per-year operational Shuttle flight rate (using a four Orbiter fleet) (4:1). To sustain this launch rate will require the agency's best effort and a strong logistical operation support capability (10:6). The Air Force Operational Test and Evaluation Center (AFOTEC) STS Launch Rate Model confirms the NASA Task Force launch rate recommendation. Table 3 (33:1) compares computed AFOTEC STS launch rates for a three and four Orbiter fleet using 60/75/90 day turnaround times (TAT). Two scenarios using KSC and VLS as STS launch sites are provided: (1) missions launched from KSC, VLS not operational, and (2) missions launched from both KSC and VLS.

AFOTEC STS LAUNCH RATE MODEL COMPUTATIONS (missions/year)		
KSC OPERATIONAL AND VLS DEACTIVATED		
TAT (days)	3 Orbiters	4 Orbiters
60	11.8	12.4
75	10.9	11.4
90	8.7	10.6
KSC AND VLS OPERATIONAL		
TAT (days)	3 Orbiters KSC/VLS*	4 Orbiters KSC/VLS*
60	9.5/4.0	11.3/4.0
75	8.1/4.0	10.7/4.0
90	6.9/4.0	8.6/4.0

* The model artificially limits the VLS launch rate to approximately four missions per year by constraining External Tank delivery to four a year.

Table 3. AFOTEC STS Launch Rate Model Data

The first scenario computes the STS launch rate with the KSC launch site operational and VLS deactivated. With a Shuttle fleet of three NASA Orbiters, the model predicts a KSC launch rate of 10.9 missions per year using a possible 75-day mission turnaround (KSC pre-Challenger TAT averaged 60 days (7:17)). Under the same conditions a four Orbiter fleet could be expected to achieve a launch rate of 11.4 missions per year. The second scenario computes the STS launch rate with both the KSC and VLS launch complexes operational. Based upon the same 75-day mission turnaround and a three Orbiter fleet, the model predicts a launch rate of 8.1 KSC and 4.0 VLS missions per year. Using the same parameters, a four Orbiter fleet could achieve a launch rate of 10.7 KSC/4.0 VLS missions per year. Two conclusions can be made from this data: (1) KSC can only increase its launch rate by one to two missions per year with VLS deactivated, and (2) building a fourth orbiter does not appear to be cost effective in lieu of the marginal impact on the launch rate. Judging potential VLS reactivation on STS launch rates alone may be deceptive. The Shuttle provides a unique flexibility not available in other space systems.

The unique distinguishing characteristics of the Shuttle is its ability to perform two-way crew transportation, manned on-orbit tasking and intervention, Strategic Defense Initiative (SDI) experimentation, spacecraft servicing, and the capability to return cargo from space. These capabilities should be seriously evaluated when considering VLS reactivation. Since no other vehicle in the space inventory can return cargo, supplies, and equipment to earth, the future successful operation and support of the SDI program and the Space Station is vitally dependent upon the Shuttle. Pre-Challenger accident Space Station support planning was based upon a resupply rate of four Shuttle flights per year from KSC (31:--). Based upon these long-term operational needs, VLS has a remote chance for reactivation. If VLS is reactivated, a minimum programmatic baseline of Shuttle vehicles must be established to ensure manned access to space.

FACILITY REACTIVATION COST

Vandenberg's future as a Shuttle launch site may hinge on the cost of reactivation. Reactivation cost from Minimum Facility Caretaker Status has not been calculated. However, using existing Mothball ($657 million dollars) and Facility Caretaker ($268 million dollars) reactivation estimates (16:Appendix I), we can project an estimated $500-$600 million dollar activation cost (does not include post-Challenger modifications or hydrogen entrapment fix). This estimate can be regarded as very conservative since the premature cancellation of Flow A eliminated any possibility of validating flight hardware and ground support system interfaces. Without a complete system validation, the probability of discovering unanticipated problems during reactivation increases significantly as does the reactivation cost.

On 4 February 1987 Headquarters USAF directed Air Force Systems Command (AFSC), with NASA participation, to develop a heavy-lift launch vehicle program (9:1). Brigadier General Rankine, Director of Air Force Space Systems Command, Control and Communications, said that "with a supplemental appropriation, the Air Force could develop an initial heavy-lift launch vehicle (redesignated Advanced Launch System (ALS)) in 1995-1996. Without funding, this capability would take an additional five years" (5:56). ALS planning is still in the concept phase; therefore, system development cost estimates are not available. To meet the HQ USAF requirement for a heavy-lift launcher, NASA proposed a modified version of the STS (Shuttle-C). The NASA heavy-lift launcher would consist of a Space Shuttle external tank, two recoverable Shuttle solid rocket boosters, an expendable payload carrier constructed from external tank components, and a recoverable propulsion/avionics module located at the bottom of the payload carrier (6:57). Delivery could occur in 1993 at a projected cost of $1.5 billion (2:3A).

DOD's key objective is to reduce launch costs by a factor of

ten compared to current Titan 4 boosters (5:57). Current launch cost is about $3000 dollars per pound to low earth orbit (FY 1987 dollars) (1:25). Air Force officials, however, believe Shuttle derived vehicles are inherently expensive because the support operations associated with Shuttle-type launches are labor intensive (5:57). The Air Force's chief objective is to develop a low-cost system, while NASA's priority is to develop a high-reliability launcher (5:57). While the Air Force would like to keep the heavy-lift vehicle a pure AF developmental project, the prohibitive expense of acquisition may force the AF and NASA into a joint developmental venture. If the NASA Shuttle-C design is accepted, then the potential for reactivating VLS SLC-6 as a heavy-lift launch complex significantly improves.

Chapter Five

SUMMARY AND CONCLUSIONS

SUMMARY

The purpose of this report has been to provide insight into the possible reactivation of the Vandenberg Launch and Landing Site as a Space Shuttle complex. The objectives of the paper were addressed in Chapters Two - Four. First, the paper attempted to describe the complexity of the program, the effects/ramifications of incomplete system testing (Flow A) and, then, identify significant hardware problems (i.e., hydrogen entrapment, Launch Mount holddown posts, Launch Control Center, and system valves) which pose expensive obstacles to potential reactivation. Next, the paper examined the rationale which led to the 2 October 1986 deactivation decision. It traced the initial three deactivation options (i.e., Operational Caretaker, Facility Caretaker, and Mothball) and their respective cost/system degrade trade-offs. A hybrid state of deactivation was finally selected--Minimum Facility Caretaker Status (MFCS). The paper described the level of VLS system and facility deactivation required by MFCS and the degree of reactivation planning. Finally, Chapter Four (VLS Future) assessed the prospects for VLS reactivation with respect to operational requirements, Air Force space policy/doctrine for manned spaceflight, VLS payload-to-orbit delivery capability, a replacement Orbiter, STS launch rate capability, facility reactivation costs, and Shuttle-C/heavy-lift launch vehicle development costs. Although the analysis overwhelmingly indicates the Shuttle will never be launched from Vandenberg, the strength of US national resolve must not be disregarded.

CONCLUSIONS

The strength of national resolve for manned polar spaceflight will chart Vandenberg's future as a west coast Shuttle facility. While expendable launch vehicles can handle most polar payloads they cannot accommodate the unique missions requiring a manned presence in space. The Shuttle's ability to handle the manned aspect is well documented, but its ability to consistently deploy critical payloads on time and in a cost-effective manner has not been satisfactorily demonstrated. These limitations have hampered NASA and the DOD in providing a viable operational Shuttle concept. Without a practical concept defining requirements and directing its use, the Vandenberg Shuttle program will continue to flounder. Only when requirements for

polar on-orbit satellite servicing, repair, retrieval, research and development, and Strategic Defense Initiative experimentation exceed the current perceived threshold-of-need, will serious consideration be given to Vandenberg's reactivation.

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GLOSSARY

AFM	Air Force Manual
AFOTEC	Air Force Operational Test and Evaluation Center
AFSC	Air Force Systems Command
DOD	Department of Defense
ELV	Expendable Launch Vehicle
FVV	Flight Verification Vehicle
FWC	Filament Wound Case
HCl	Hydrogen Chloride
HQ USAF	Headquarters United States Air Force
IOC	Initial Operating Capability
KSC	Kennedy Space Center
LCC	Launch Control Center
MFCS	Minimum Facility Caretaker Status
MOL	Manned Orbiting Laboratory
NASA	National Aeronautics and Space Administration
SDI	Strategic Defense Initiative
SLC-6	Space Launch Complex-6
SPC	Shuttle Processing Contractor
SPT	Shared Processing Team
SRB	Solid Rocket Booster
SSME	Space Shuttle Main Engine
SSV	Space Shuttle Vehicle
STS	Space Transportation System
TAT	Turnaround Time
VLS	Vandenberg Launch and Landing Site
WTR	Western Test Range